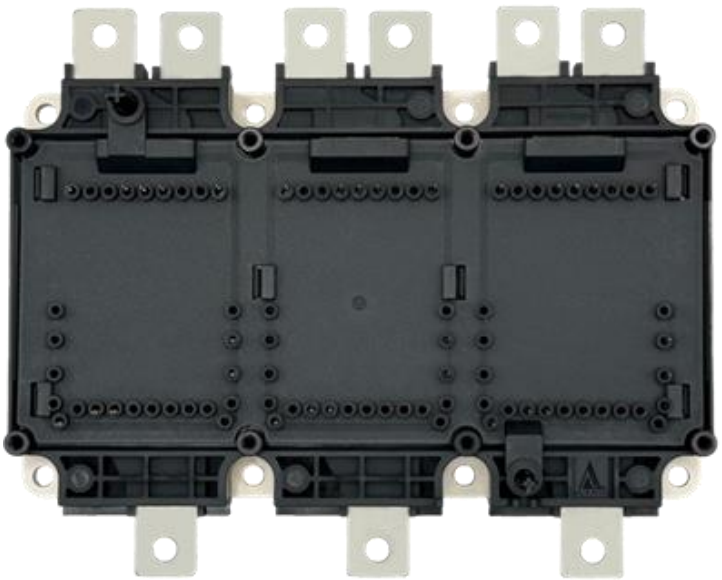
1200V SiC HPD Power Module

AEPR25B12C1ST

PRELIMINARY
DATASHEET

V0.3, 2024/11



Applications

- Motor Drives
- All-Terrain Vehicles
- Automotive Applications
- Hybrid Electrical Vehicles (xEV)
- Commercial Agriculture Vehicles

Features

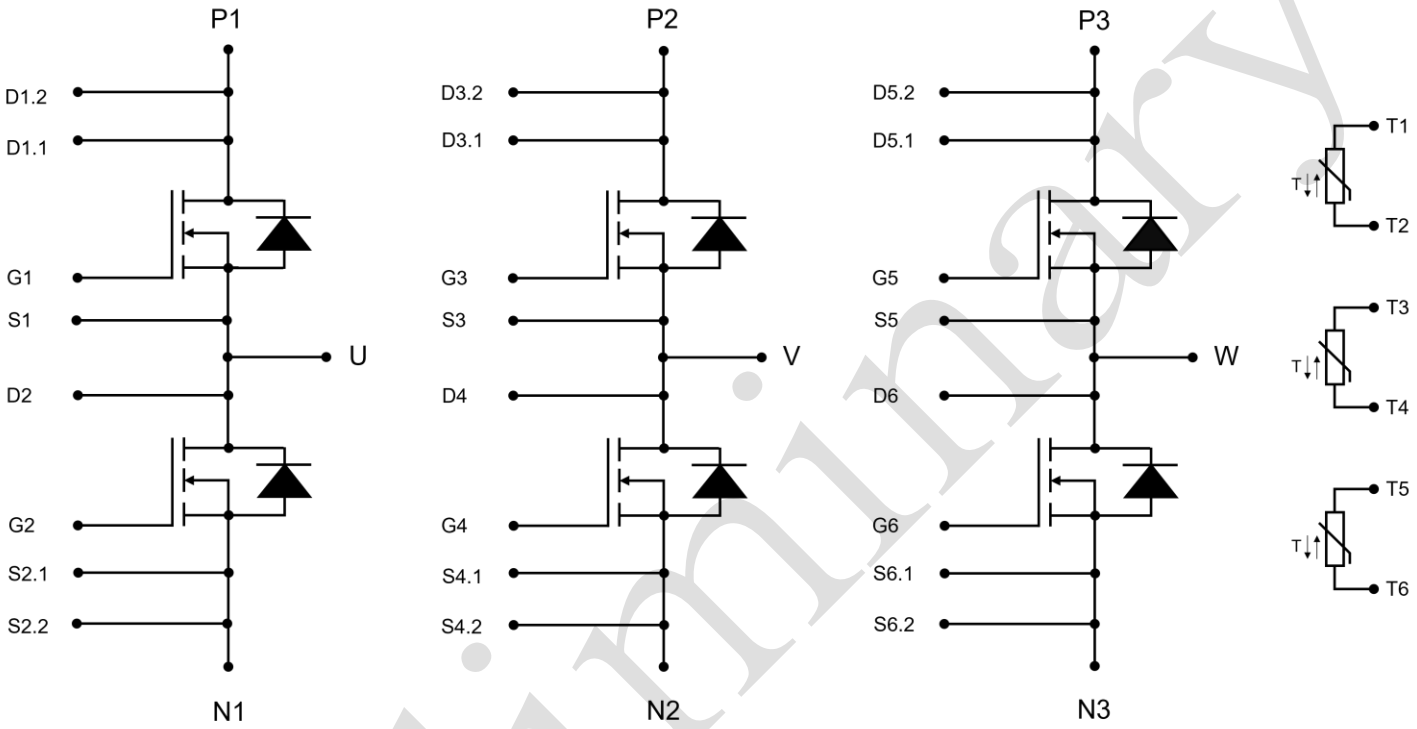
Electrical Features

- Low $R_{DS(on)}$
- $T_{j,op}$ = 150°C
- Blocking Voltage 1200V
- DC Drain Current 400A
- Low Switching Losses
- Low Inductance Design
- SiC MOSFET Technology

Mechanical Features

- Sintered Ag Technology
- Si_3N_4 Ceramic Substrate
- Direct Liquid Cooled Baseplate
- Compact Design
- 4.2kV DC Insulation
- Press-Fit Pin Connection
- UL 94 Module Frame
- NTC Temperature Sensor Included
- Pb-Free and RoHS Compliant
- Guiding Element for PCB and Cooler Assembly

Circuit Diagram



MOSFET

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
Drain-source voltage	T_j = 25°C	V_{DSS}	1200	V
Gate-source voltage		V_{GS}	-10/+23	V
	Recommended operating values	V_{GS}	-5/+18	V
DC drain current	V_{GS} = 18V, T_F = 60°C, $T_{j,max}$ = 175°C	$I_{D\ nom}$	400	A
Pulsed drain current	t_p limited by $T_{j,\ max}$	$I_{D\ pulse}$	800	A
Maximum junction temperature		$T_{j,max}$	175	°C

Characteristics Values

Parameter	Conditions		Symbol	Min.	Typ.	Max.	Unit
Drain-source on resistance	I_D = 400A, V_{GS} = 18V	T_j = 25°C	$R_{DS(on)}$		2.50	3.40	mΩ
	I_D = 400A, V_{GS} = 18V	T_j = 150°C			3.85		
	I_D = 400A, V_{GS} = 18V	T_j = 175°C			4.40		
Gate threshold voltage	I_D = 210 mA, V_{GS} = V_{DS}	T_j = 25°C	$V_{GS,th}$	1.80	2.50	3.30	V
		T_j = 150°C			1.90		
		T_j = 175°C			1.80		
Drain-source leakage current	V_{DS} = 1200V, V_{GS} = 0V	T_j = 25°C	I_{DSS}			100	µA
		T_j = 150°C				1	mA
		T_j = 175°C				5	mA
Gate-source leakage current	V_{DS} = 0V, V_{GS} = 20V	T_j = 25°C	I_{GSS}			400	nA
Gate charge	V_{GS} = -5V / + 18V V_{DS} = 600V, I_D = 400A	T_j = 25°C	Q_G		1.9		µC
Input capacitance	f = 100 kHz, V_{DS} = 600V V_{GS} = 0V	T_j = 25°C	C_{iss}		45.0		nF
Output capacitance	f = 100 kHz, V_{DS} = 600V V_{GS} = 0V	T_j = 25°C	C_{oss}		2.0		nF
Reverse transfer capacitance	f = 100 kHz, V_{DS} = 600V V_{GS} = 0V	T_j = 25°C	C_{rss}		0.17		nF

Parameter	Conditions		Symbol	Min.	Typ.	Max.	Unit
Turn-on delay time inductive load	I_D = 400A, V_{DS} = 600V V_{GS} = -5V / + 18V $R_{G,on}$ = 5.1 Ω	T_j = 25°C T_j = 175°C	$t_{d(on)}$		110 78		ns
Rise time, inductive load	I_D = 400A, V_{DS} = 600V V_{GS} = -5V / + 18V $R_{G,on}$ = 5.1 Ω	T_j = 25°C T_j = 175°C	t_r		226 186		ns
Turn-on energy loss per pulse	I_D = 400A, V_{DS} = 600V L_S = 30 nH V_{GS} = -5V / + 18V $R_{G,on}$ = 5.1 Ω di/dt = 4.1 A/ns (25°C) di/dt = 4.8 A/ns (175°C)	T_j = 25°C T_j = 175°C	E_{on}		18.1 17.9		mJ
Turn-off delay time Inductive load	I_D = 400A, V_{DS} = 600V V_{GS} = -5V / + 18V $R_{G,off}$ = 5.1 Ω	T_j = 25°C T_j = 175°C	$t_{d(off)}$		535 656		ns
Fall time, inductive load	I_D = 400A, V_{DS} = 600V V_{GS} = -5V / + 18V $R_{G,off}$ = 5.1 Ω	T_j = 25°C T_j = 175°C	t_f		108 114		ns
Turn-off energy loss per pulse	I_D = 400A, V_{DS} = 600 V L_S = 30 nH V_{GS} = -5V / + 18V $R_{G,off}$ = 5.1 Ω dv/dt = 5.6 V/ns (25°C) dv/dt = 5.3 V/ns (175°C)	T_j = 25°C T_j = 175°C	E_{off}		26.0 28.5		mJ
Short circuit current	V_{DD} = 800V V_{GS} = -5V / + 18V $R_{G,on}$ = 5.1 Ω $R_{G,off}$ = 5.1 Ω t_{sc} ≤ 3 µs	T_j = 25°C T_j = 150°C	I_{SC}		6800 5700		A
Thermal resistance Junction to cooling fluid	Per MOSFET ΔV/Δt = 10 dm^3/min T_F = 60°C		$R_{th,JF}$		0.09		K/W
Operated temperature condition			$T_{j,op}$	-40		150	°C

Body diode

Maximum Rated Values

Parameter	Conditions	Symbol	Values	Unit
DC body diode forward current	V_{GS} = -5V, T_j = 175°C	I_{SD}	210	A
Pulsed body diode current	t_p limited by $T_{j,max}$	$I_{SD\ pulse}$	800	A

Characteristics Values

Parameter	Conditions		Symbol	Typ.	Max.	Unit
Forward voltage	I_{SD} = 400A, V_{GS} = -5V	T_j = 25°C T_j = 150°C T_j = 175°C	V_{SD}	5.20 4.45 4.40	6.00	V
Peak reverse recovery current	I_{SD} = 400A, V_R = 600V V_{GS} = -5V	T_j = 25°C T_j = 175°C	I_{RM}	68 169		A
Recovered charge	I_{SD} = 400A, V_R = 600V V_{GS} = -5V	T_j = 25°C T_j = 175°C	Q_{rr}	2.2 7.7		µC
Reverse recovery energy	I_{SD} = 400A, V_R = 600V V_{GS} = -5V -di/dt = 4.1 A/ns (25°C) -di/dt = 4.8 A/ns (175°C)	T_j = 25°C T_j = 175°C	E_{rec}	0.6 2.3		mJ

NTC-Thermistor

Characteristics Values

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Rated resistance	T_c = 25°C	R_{25}		5.0		kΩ
Resistance tolerance	T_c = 100°C	ΔR/R	-5		5	%
B-value	$R_2 = R_{25}\ \exp[B_{25/50}(1/T_2 - 1/(298.15\ K))]$	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25}\ \exp[B_{25/80}(1/T_2 - 1/(298.15\ K))]$	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25}\ \exp[B_{25/100}(1/T_2 - 1/(298.15\ K))]$	$B_{25/100}$		3433		K

Module

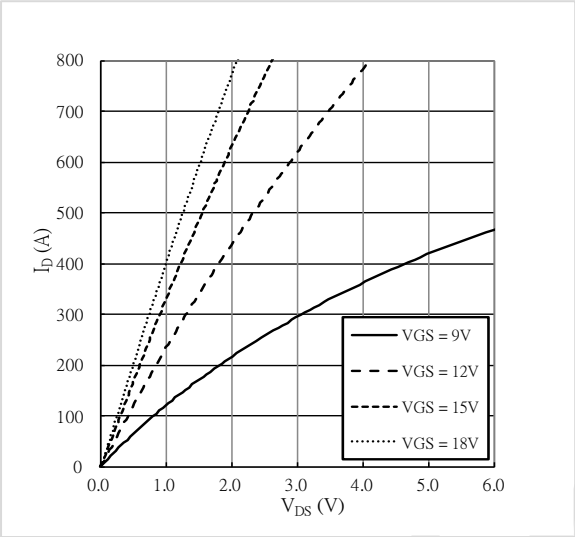
Parameter	Conditions	Symbol	Value	Unit
Isolation test voltage	RMS, f = 0 Hz, t = 1 sec	V_{ISOL}	4.2	kV
Module baseplate material			Cu + Ni	
Module internal isolation material	Basic isolation (class 1, IEC 61140)		Si_3N_4	
Creepage distance	Terminal to heatsink	$d_{Creep,TH}$	9.0	mm
Creepage distance	Terminal to terminal	$d_{Creep,TT}$	9.0	mm
Clearance distance	Terminal to heatsink	$d_{Clear,TH}$	4.5	mm
Clearance distance	Terminal to terminal	$d_{Clear,TT}$	4.5	mm
Comparative tracking index [1)]		CTI	> 200	

Parameter	Conditions	Symbol	Min.	Typ.	Max.	Unit
Module stray inductance		L_{sDS}		9		nH
Storage temperature		T_{stg}	-40		125	°C
Mounting torque for module mounting	Screw M4 baseplate to heatsink	M	1.80	2.00		Nm
Weight		G		745		g

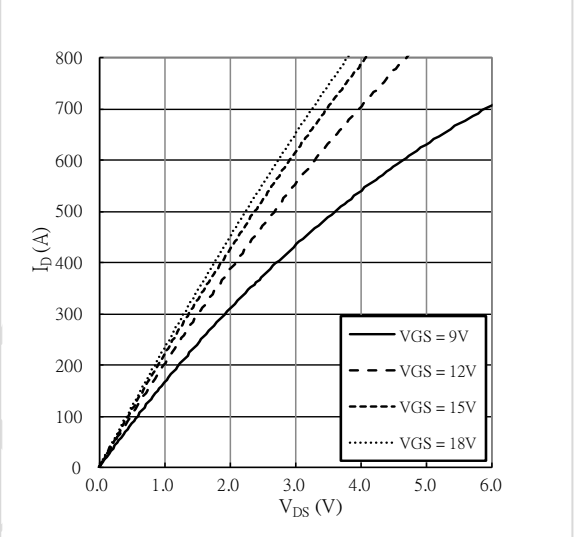
1) Extracted by following UL 746A

Characteristics Diagrams

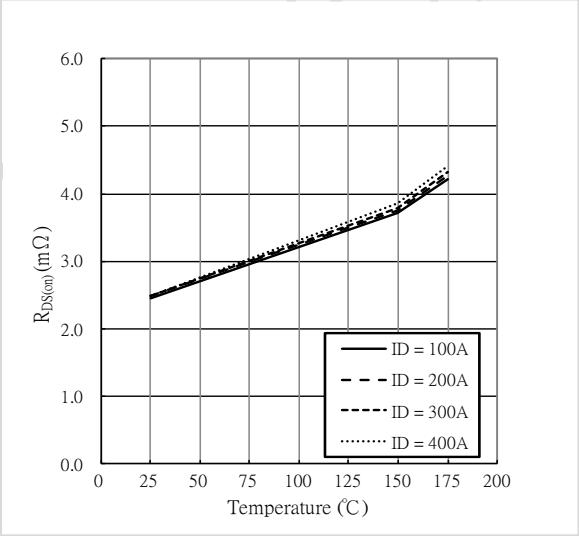
MOSFET, Output characteristics
T_j = 25°C, I_D = f(V_{DS})



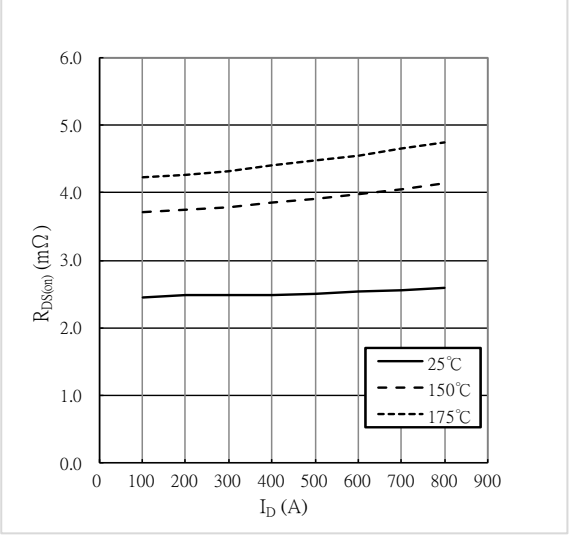
MOSFET, Output characteristics
T_j = 175°C, I_D = f(V_{DS})



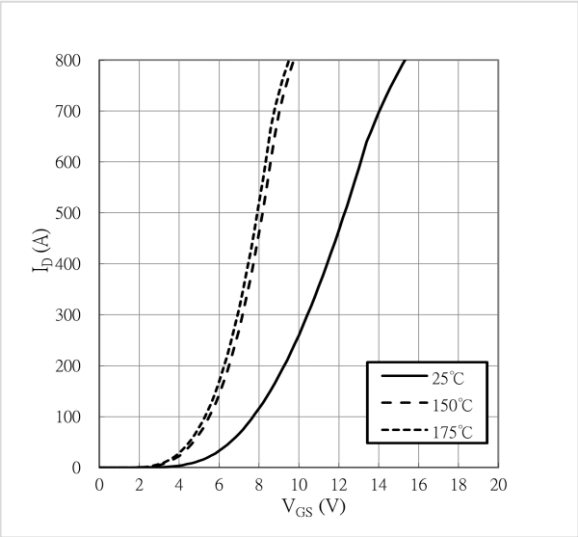
Typical temperature dependence of $R_{DS(on)}$
V_{GS} = 18V, $R_{DS(on)}$ = f(T_j)



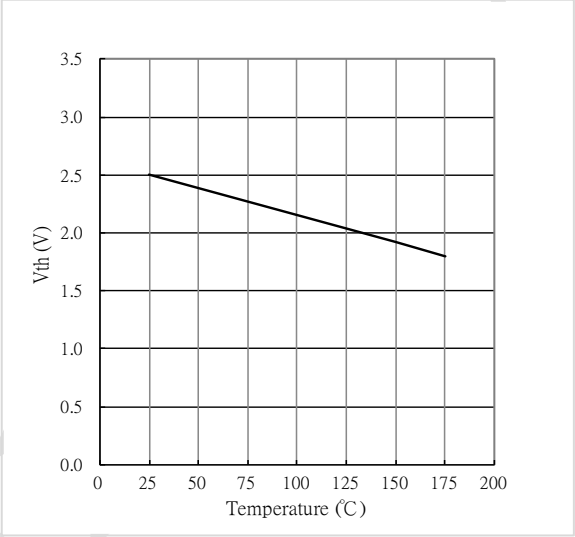
Typical temperature dependence of $R_{DS(on)}$
V_{GS} = 18V, $R_{DS(on)}$ = f(I_D)



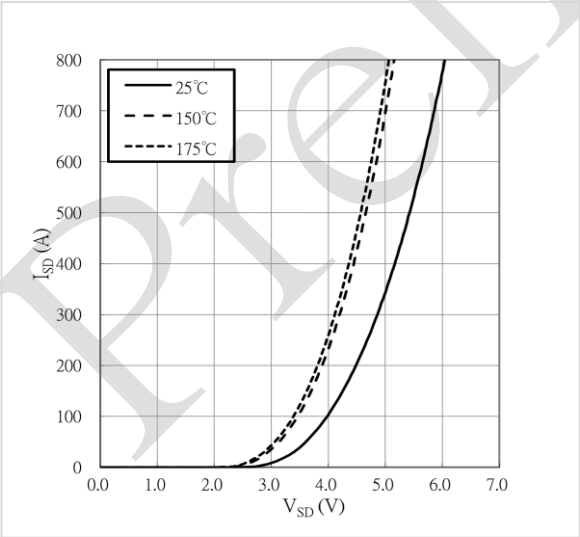
MOSFET, Transfer characteristics
$I_D = f(V_{GS})$



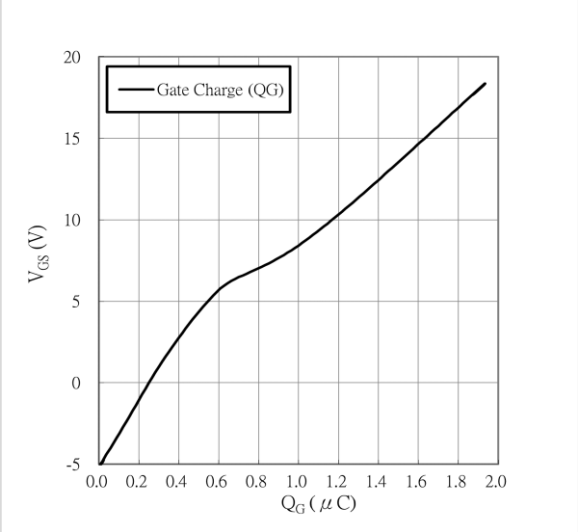
Typical temperature dependence of threshold voltage, $V_{th} = f(T_j)$



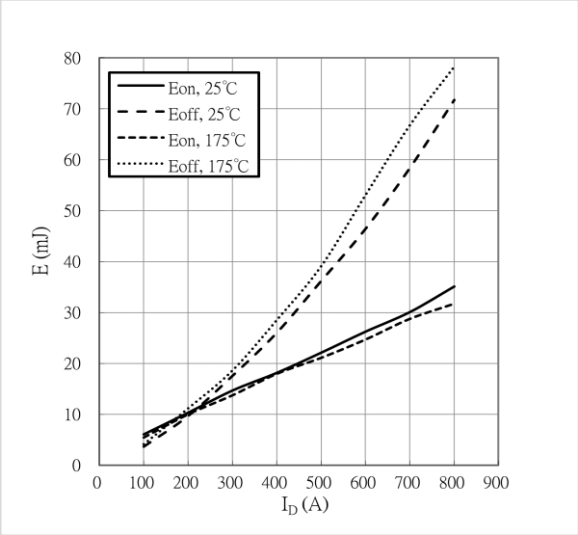
Diode Forward characteristics
V_{GS} = -5V, $I_{SD} = f(V_{SD})$



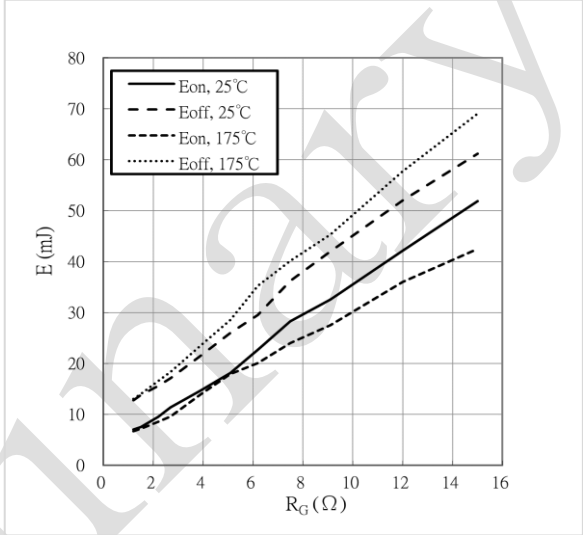
MOSFET, Total gate charge characteristics
V_{DS} = 600V, I_D = 400A, T_j = 25°C, $V_{GS} = f(Q_G)$



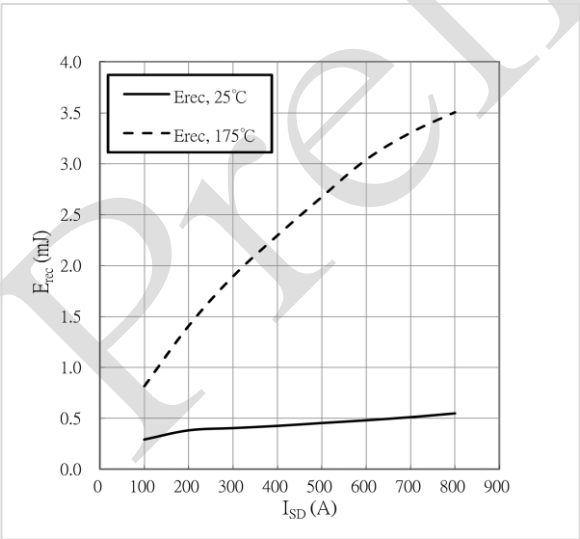
MOSFET, Switching losses VS. I_D
V_{GS} = -5V / +18V, $R_{G,on}$ = 5.1Ω, $R_{G,off}$ = 5.1Ω
V_{DS} = 600V, E_{on} & E_{off} = f(I_D)



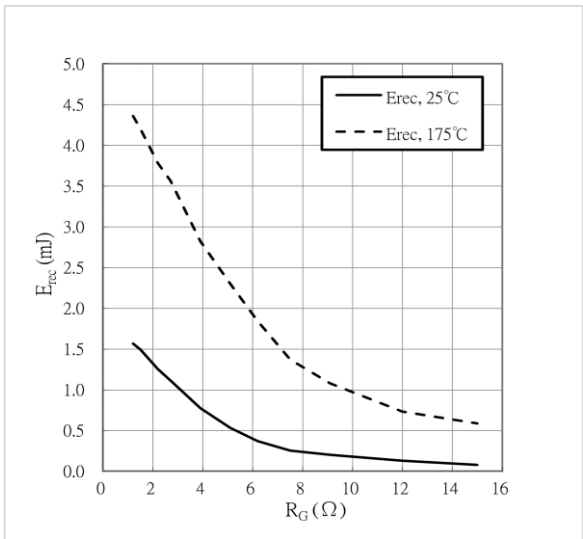
MOSFET, Switching losses VS. R_G
V_{GS} = -5V / +18V, V_{DS} = 600V, I_D = 400A
E_{on} & E_{off} = f(R_G)



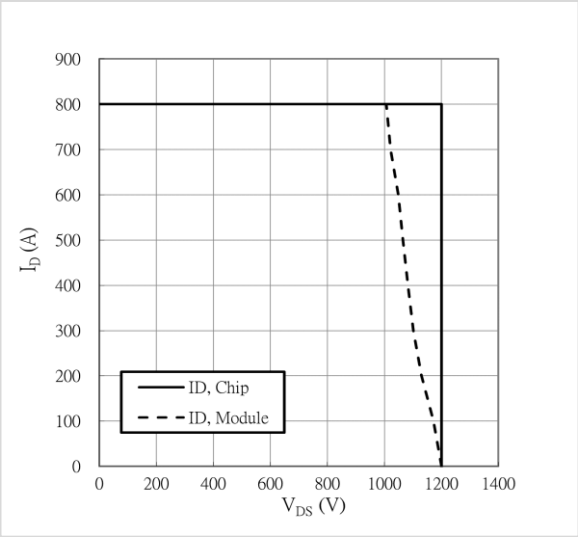
Diode, Switching losses VS. I_{SD}
V_{GS} = -5V / +18V, $R_{G,on}$ = 5.1Ω, $R_{G,off}$ = 5.1Ω
V_{DS} = 600V, E_{rec} = f(I_{SD})



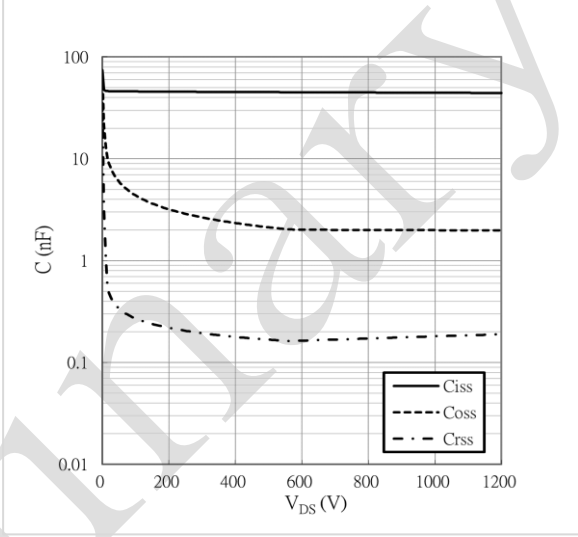
Diode, Switching losses VS. R_G
V_{GS} = -5V / +18V, V_{DS} = 600V, I_{SD} = 400A
E_{rec} = f(R_G)



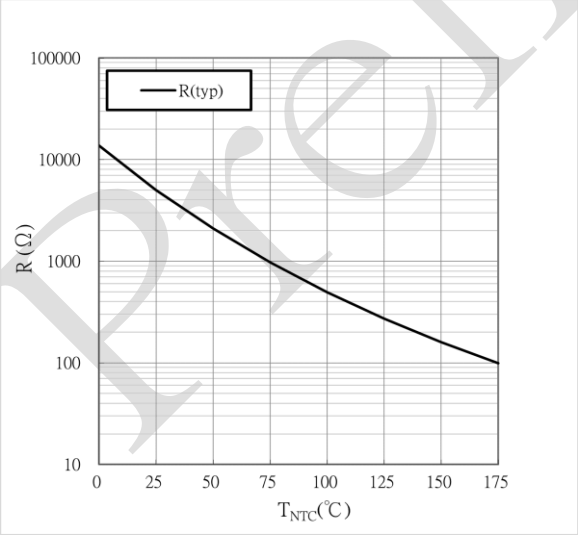
MOSFET, Reverse bias safe operating area
(RBSOA)V_{GS} = -5V/ +18V, $R_{G,on}$ = 5.1Ω
$R_{G,off}$ = 5.1Ω, T_j = 175°C, I_D = f(V_{DS})



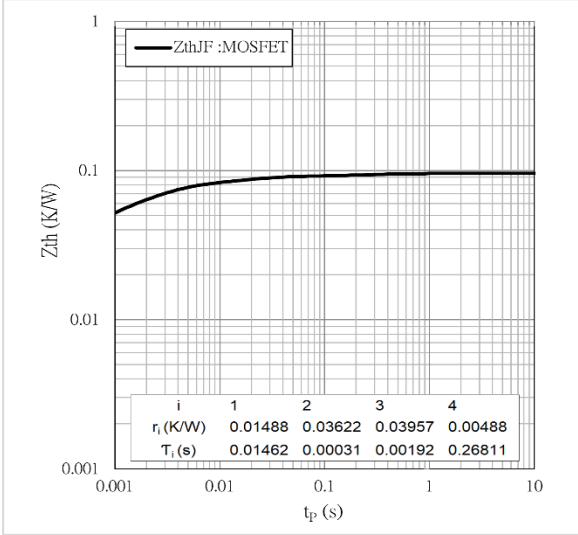
MOSFET, Capacitance characteristics
V_{GS} = 0V, T_j = 25°C, f = 100 kHz, C = f(V_{DS})



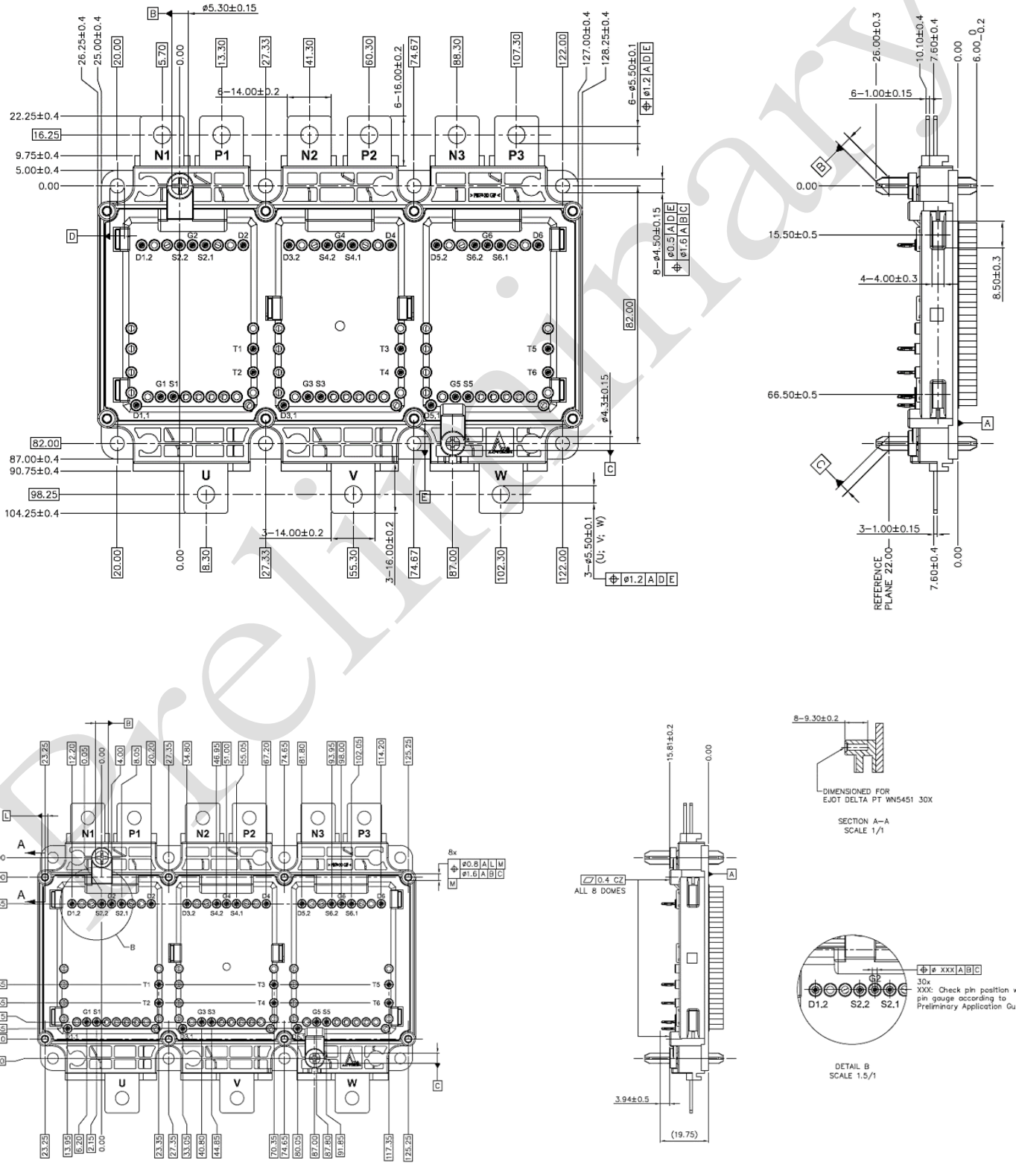
NTC-Thermistor-temperature characteristics
R = f(T_{NTC})



MOSFET, Transient thermal impedance
Z_{thJF} = f(t_P)
ΔV/Δt = 10 dm^3/min, T_F = 60°C



Package Outlines



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